1994 Annual Report

Georgia Tech

RESEARCH INSTITUTE

1994 Annual Report

Cover: *Composite imagery at 10-meter resolution from the LANDSAT and SPOT satellites was combined with an experimental geographic information system (GIS) model to show the extent of flooding in Albany, Georgia, during heavy rainfall associated with Hurricane Alberto in July 1994. Area in orange on the inset photos shows the progression of flooding in the city. The imaging was performed for the Federal Emergency Management Agency by the Joint Centers of Geographic Information Systems and Spatial Analysis Technology, which are composed of scientists from the U.S. Geological Survey/Water Resources Division, Georgia Department of Natural Resources, and Georgia Tech Research Institute. Researchers believe the study could lead to development of a new means for predicting the extent of flooding based on geographic information and knowledge of the rainfall received in watershed areas upstream of major cities. Such predictions could help authorities define flood danger areas and provide more time for evacuation.*

The Year in Review

Fiscal 1994 was a year of organizational change and new research thrusts at the Georgia Tech Research Institute (GTRI).

In adapting to the downsizing of the Department of Defense research budget, we enacted a series of management initiatives to reduce costs and improve efficiency. These actions are helping to establish GTRI at the forefront of the nation's new societally oriented research agenda.

Research initiatives include work in areas such as transportation, electronics, and educational technology. Leadership for these and other R&D thrusts is being provided by new senior faculty leaders in cutting-edge disciplines. Other vehicles for research diversification are interdisciplinary centers, such as the Phosphor Technology Center of Excellence, which is building a strong technology base for high-definition display screens.

Financially, the uncertain federal research funding environment contributed to a slight downturn in R&D support at GTRI. Grants and awards dropped by 11 percent to $78.5 million; however, a strong contract backlog allowed us to weather this shortfall with only a 3.6 percent drop in expenditures to $94.6 million. Industrial and nondefense sponsored contracts increased by 4.4 percent. A break-out of sponsorship trends is shown in the chart on "Major Sponsors."

On a sad note, GTRI Executive Associate Director, Robert G. Shackelford, passed away on November 23, 1993. Bob had served the organization for 34 years. His wise leadership will be greatly missed. This annual report is dedicated to his memory.

Strategic Directions

GTRI's new strategic plan, first developed during FY 93, began to show promising results in FY 94.

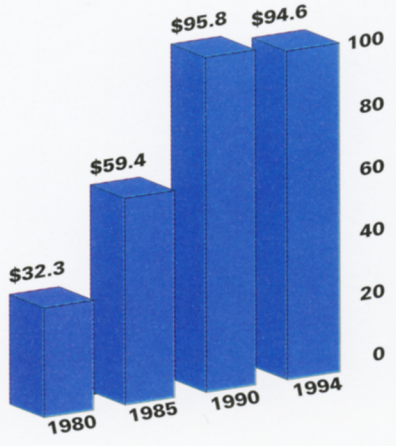
A council of eminent researchers, known as the GTRI Fellows Council, took office and soon approved its first slate of internally supported projects. In addition, an intensive effort began to seek more internationally funded research contracts, in line with an organizational goal to increase such contracts to 10 percent by 1997. We also took part in several productive joint ventures with Clark Atlanta University, including a study of storage reliability of gallium arsenide components used in smart munitions.

In line with our emphasis on efficiency, we undertook vigorous measures to lower costs and improve efficiency. Service departments were reorganized, cutting research support and financial services costs by 10 percent through attrition and staff reassignment.

Major Sponsors
(percentage of research expenditures)

- Air Force 32.4%
- Army 29%
- Industry 16.6%
- NASA 3.2%
- Navy 2.9%
- Other DoD 8.1%
- Other Federal 6.4 %
- State/Local 1.4%

Research Expenditures
(dollars in millions)



Individual researchers continued to win recognition from their peers outside of GTRI. Principal Research Scientist Krishan Ahuja received the most prestigious honor in the field of aeroacoustics, the international 1993 American Institute of Aeronautics and Astronautics Aeroacoustics Award, for his advancement of aeroacoustical sciences. Ahuja was also named Regents' researcher, the only current GTRI faculty member so honored. In addition, a specialist in millimeter wave technology, Robert W. McMillan, was named a Fellow of the Institute of Electrical and Electronics Engineers (IEEE). McMillan joins five other IEEE Fellows at GTRI.

GTRI is active at the national level, with a member of the Defense Policy Board, the Naval Studies Board, the Air Force Scientific Advisory Board, and two members of the Army Science Board.

Contributions to Education

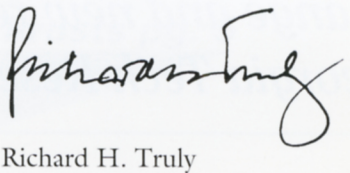
In FY 94 GTRI employed a total of 217 graduate students and 294 undergraduate students.

GTRI offers graduate research assistantships to students of exceptional academic merit. Current membership stands at 27. Last January, these scholars were named the Robert G. Shackelford Fellows in honor of our late executive associate director.

Service to Georgia

Georgia Tech's new Economic Development Institute has become the central point for tapping the university's expertise from outside the campus. EDI includes the former GTRI Economic Development Laboratory, and GTRI continues to promote the state's economy through its agricultural technology research, environmental assistance programs, and defense conversion efforts, which have been expanded to involve collaboration with Georgia industry.

Let me close by expressing my thanks to the many people inside and outside Georgia Tech who have contributed to the Research Institute's continued vitality. My deepest gratitude goes to GTRI's staff members, who continue to show their commitment to the development of high-quality research.



Richard H. Truly
Vice President,
Georgia Institute of Technology
Director,
Georgia Tech Research Institute

New Beginnings at GTRI

The Georgia Tech Research Institute (GTRI) is a nonprofit, client-oriented, applied research organization that is an integral part of the Georgia Institute of Technology. GTRI conducts research in engineering, science, computer technology, and other areas of study for a wide range of sponsors, including federal, state, and local governmental agencies, industrial firms, and private organizations.

Changing national priorities have led GTRI to redirect these research and development energies toward several new initiatives which hold great promise. These include GTRI's advanced concepts thrusts, participation in national defense conversion efforts, internally sponsored research, and the work of the six current senior faculty leaders. At the same time GTRI is beginning these new efforts, its traditional research programs are evolving in many exciting directions.

Advanced Concepts Thrusts

GTRI's recent restructuring created an Advanced Concepts Office which nurtures initiatives in new areas of strong research potential. This year the office has targeted the following topics for emphasis.

Educational Technology

In FY 95, the Educational Technology Initiative will host a series of events bringing together representatives of local industry and government who are interested in education and training technology. Through these forums GTRI will forge the key partnerships that are increasingly necessary to advance technology.

GTRI has made a strong commitment to advancing educational technology. Researchers from three GTRI laboratories and other campus units are collaborating to:

- Develop interactive multimedia course work in selected areas
- Enhance the public information infrastructure, especially in K-12 schools
- Develop applications transforming defense technology investments into learning resources

Medical Technology

The Medical Technology Group has been redirecting advances made in GTRI's successful defense research toward medical diagnosis and healing, as well as the prevention of injury and disease.

Researchers at GTRI are building on the increasingly important link between engineering and medicine. Their work, which draws on GTRI's established strengths in defense research, centers on:

- Diagnostic signal processing for magnetic resonance images
- Computer-assisted diagnosis for digital mammography
- 3-D facial-animation analysis
- Effective human/machine interfaces
- A portable, smart magnetic resonance imaging system
- Radio-frequency hazards in both intelligent vehicle/highway systems and in cellular and personal communications systems

Modeling and Simulation

Modeling and simulation (M&S) has been identified as a critical technology for the continued prosperity of the United States. This year the mission of the M&S group is to utilize the resources of Georgia Tech and GTRI to meet the technology requirements of emerging critical applications.

The M&S group will focus on supporting and adding capabilities to other disciplines and thrust areas such as:

- Education
- Manufacturing
- Medicine
- Environmental technologies
- Health care informatics
- Enterprise engineering

This page: *GTRI has begun a new initiative to develop educational technology, particularly in the area of interactive multimedia courseware.*
Opposite page: *Traffic signal controllers are safer from electromagnetic interference effects thanks to GTRI recommendations on grounding and protection.*

Transportation

Advanced transportation is a key element in America's efforts to compete in global markets. GTRI plays a major role in transportation-related research, providing a broad spectrum of technical expertise and working cooperatively with Georgia Tech's Transportation Research and Education Center (TREC) and academic researchers across campus.

GTRI researchers in advanced transportation include specialists in human factors, sensor development, signal processing, communications, vehicle design and construction, automobile noise, electromagnetic interference, and transportation systems analysis. Their current research includes externally funded work such as:

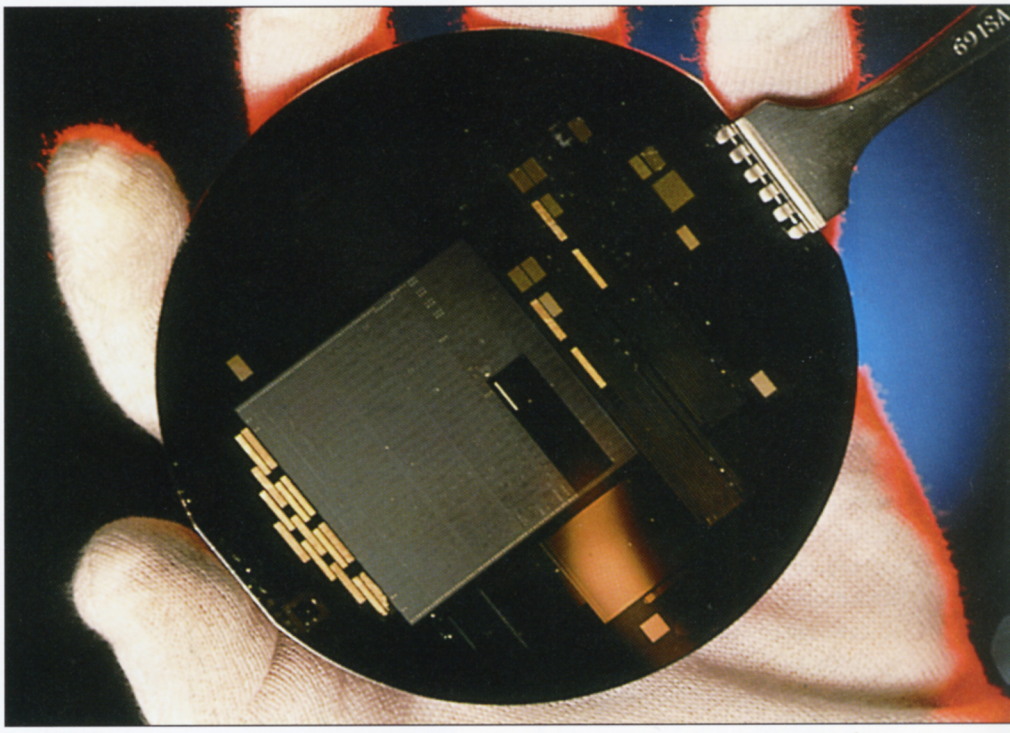
- Ease of operator use in advanced traffic management systems
- Automated highway system studies
- Adverse visibility warning systems for highways
- Electric vehicles
- Vehicle noise studies
- Traffic signal monitoring equipment accuracy

GTRI is currently expanding its transportation research in:

- Hydrogen fuel vehicles
- Advanced electric vehicles
- A prototype automated highway system
- An overheight monitoring system
- Automated traveler information system communication

Defense Conversion

GTRI has responded rapidly and effectively to the call to adapt defense technology for the private sector through the Technology Reinvestment Project (TRP). GTRI, through Georgia Tech, is a participant in 26 of Georgia's 33 TRP proposals, collaborating with such partners as Rockwell, BellSouth, Hughes, the state of South Carolina, and the Georgia Research Alliance. Six of these proposals were selected for funding by the Advanced Research Projects Agency (ARPA).



Wireless Communication Engine

Georgia Tech is collaborating with Rockwell International and Bel-Tronics to develop a wireless communication engine which Bel-Tronics will integrate into high-volume consumer products to be manufactured at a new engineering and manufacturing facility in Covington, Georgia. This project will directly contribute to a significant number of new jobs in Georgia.

Georgia Tech, Rockwell International, and Bel-Tronics, Limited are drawing on the successful Global Positioning System engine developed by Rockwell to design a flexible subsystem supporting:

- Rapid prototyping
- Development
- Manufacturing of wireless telecommunications products
- Military and commercial wireless applications

Multichip Module Consortium

Multichip modules (MCMs) are expected to replace conventional printed wiring boards with "super-chips." The advanced MCM technology being developed by Georgia Tech and this consortium will help local PC board and communications manufacturers compete in the Personal Communicator market.

Georgia Tech is collaborating with a consortium of industry and national laboratories to develop:

- Designs
- Equipment
- Materials for low-cost, high-volume, multichip module technology

Southeastern Environmental Resources Alliance (SERA)

Environmental issues and enhanced economic development are the driving forces behind SERA. This alliance among state universities, Westinghouse Savannah River Site (WSRS), and the Department of Energy will provide industries with immediate access to technologies developed at the WSRS, enhance state-based knowledge, and provide a national focus on SERA and its participants.

Georgia and South Carolina, along with several governmental and educational organizations from each state, are joining forces to develop technological resources at WSRS. Industry in both states will benefit from the resulting manufacturing-focused

environmental technologies. These benefits will include:

- New solutions to industrial emission problems
- New industries using environmentally benign processes and systems
- Expansion of industries serving environmental products companies

Georgia Manufacturing Extension Alliance

GTRI participates in this partnership between Georgia Tech's Economic Development Institute (EDI) and Georgia's primary technical and management assistance providers. The program establishes a new model for delivering management and technical assistance to defense-dependent and small manufacturers, enabling them to become more productive and competitive in today's global economy.

Georgia has more than 9,000 small- and mid-sized manufacturers, employing some 550,000 residents in industries such as carpet, wood products, transportation equipment, and others vital to the state's economic growth. This alliance uses EDI's existing extension offices as "gateways" to these companies, delivering services such as:

- On-site technical assistance
- Assessments
- Seminars and workshops
- Manufacturing networks
- Publications

Multimedia In Manufacturing Education

MIME (Multimedia in Manufacturing Education) will use leading-edge, interactive multimedia to revolutionize manufacturing education, eventually making it available through the electronic superhighway (Internet) to all citizens, locally and nationally.

In its initial phases, MIME participants will design, produce, and deliver three leading-edge interactive multimedia programs overcoming the shortfalls of traditional classroom-based instructional techniques.

This page: *The Georgia Manufacturing Alliance will provide technical and management assistance to small- and mid-sized manufacturers.*
Opposite page: *GTRI is participating in several ARPA-funded electronic packaging research programs to develop low-cost, high-volume electronic modules.*

Internal Research

GTRI's Internal Research Program encourages and supports new research efforts in growth areas, particularly those offering significant societal benefits. Allocation of these funds is based on a highly competitive process, which culminated in six projects being funded this year.

FutureCar

Georgia Tech's FutureCar project demonstrates technologies two generations ahead of current capabilities which will make automobile manufacturing and vehicles safer and more efficient. These futuristic technologies are being tested today by GTRI researchers.

Technologies being investigated as part of the FutureCar project include:

- Energy capture and storage
- Power generation and transmission
- Active and passive drag reduction techniques
- Vision systems
- Techniques to enable easier manufacturing and maintenance

3-D Wind Field Mapping

3-D wind field mapping by lidar promises to enhance aviation safety by improving detection of wind shear and turbulent conditions. It also will improve pollution control by providing remote sensing of the movement of particulate mass.

GTRI researchers involved in the wind field mapping project are developing:

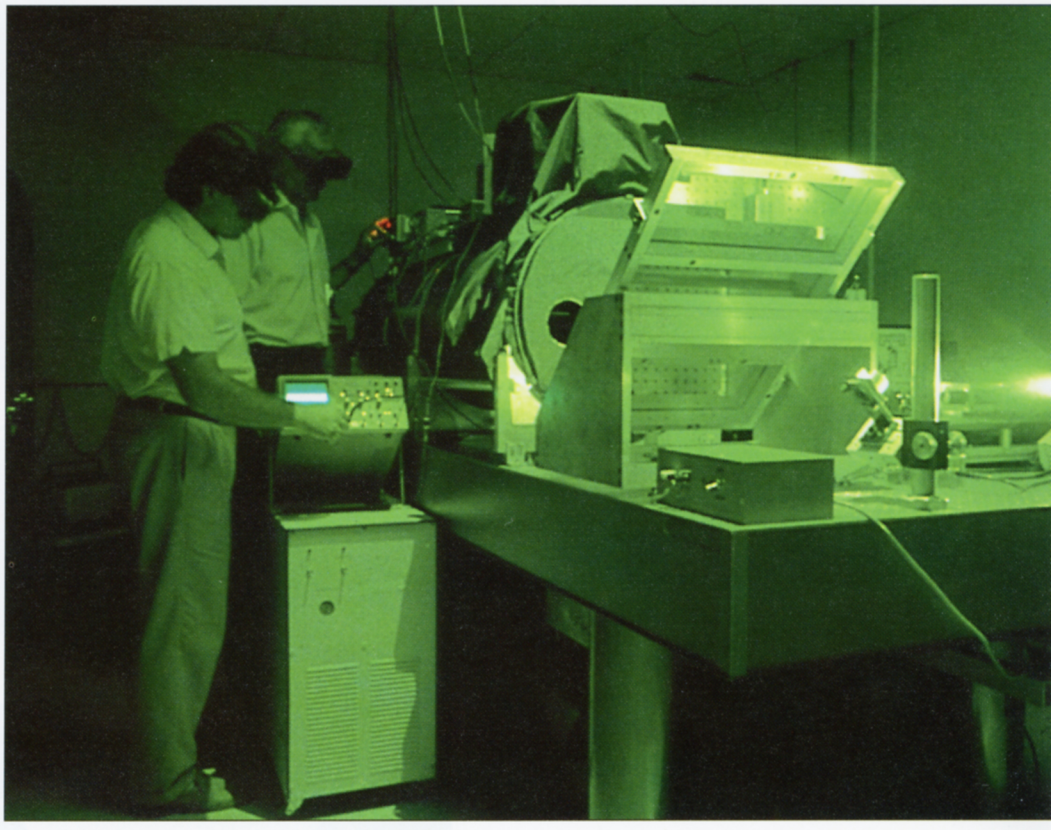
- A new lidar system
- Special purpose software to calculate the statistics of photon counts
- A new method for statistical analysis of the data from a photon-counting lidar
- Software to control the lidar data system and data file acquisition

Intelligent Traffic Management

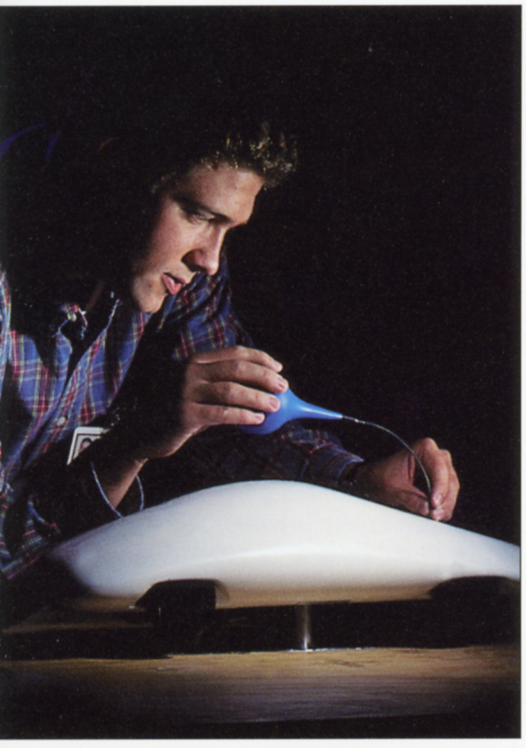
GTRI investigators are using their expertise in modeling, simulation, neural networks, and expert systems to develop an adaptive traffic management system which will meet 21st century needs.

The Intelligent Traffic Management project is developing and constructing:

- An intelligent control architecture using neural networks
- Distributed, dynamic processing for real-time traffic management
- Independent knowledge sources which can be controlled by the central system



This page: *GTRI researchers are developing a new wind sensing system that uses lidar technology.*
Opposite top: *GTRI researchers prepare their FutureCar model for an 85 m.p.h. wind tunnel test. FutureCar is designed to demonstrate technologies that are two generations ahead of current automotive concepts.*
Opposite bottom: *Researchers evaluate results from the Georgia Tech vision simulation and observer testing laboratory.*



Nondestructive Testing

This project is investigating the use of lasers, ultrasound, and Laser Doppler Velocimetry (LDV) for nondestructive testing. Because these systems are noncontact, easily applied to scanning systems, and can be used in adverse environments, they will be major assets in improving manufacturing quality control.

Major applications include:

- Finding residual manufacturing stresses by measuring the polarization of laser-generated shear waves with the LDV
- Locating poor solder joints in electronic circuit boards by using the LDV to detect reflections of ultrasonic pulses

Simulating Human Vision

An interdisciplinary team of Georgia Tech researchers is enhancing a vision simulation so it more closely mimics actual human vision. The improved simulation will be used in fields as diverse as industrial inspection, biomedical image screening, and intelligent automotive systems, as well as a variety of military applications. This project also brings Georgia Tech closer to its goal of becoming a center of excellence in computational vision research.

This project is the first to incorporate feedback into a simulation of human vision. This work is divided into four interwoven parts:

- Formulation of the feedback algorithms
- Algorithm review to ensure consistency with human vision anatomy and physiology
- Conversion of the algorithms to a form compatible with the existing model
- Review of algorithms to ensure high-level signal processing and computational efficiency

Re-educating the Human Brain

Researchers from GTRI, Emory University, and the Atlanta Speech School are evaluating emerging technologies that capitalize on the brain's compensatory abilities to alleviate developmental and adult disabilities. These technologies also hold promise for easing auditory problems in speech comprehension and sound sensitivities.

This project is evaluating the efficacy of Modulated Auditory Stimulation (MAS) for use in cases of auditory disturbances and possibly related behavioral and attentional problems. The multidisciplinary evaluation has three facets:

- Analyzing the engineering claims of a commercially available stimulation device
- Evaluating auditory and behavioral function of speech- and language-impaired children before and after MAS
- Evaluating electroencephalographs of subjects before and after MAS to identify potential brain-behavior relationships

Senior Faculty Leaders

Advanced Photonic Materials

Robert E. Schwerzel, Ph.D.

Dr. Robert Schwerzel and his colleagues design, fabricate, and characterize materials and devices with advanced optical, electronic, and mechanical properties.

This team is producing a new type of composite material, nanocomposite semiconductor-polymers, in which surface-functionalized semiconductor crystallites are chemically cross-linked into a photocurable polymer resin. This process could help make it easier to design nanocomposite polymers with superior optical and mechanical properties for use in integrated-optic devices and bulk optical devices.

Center for Enterprise Systems

Gary S. Tjaden, Ph.D.

Dr. Gary Tjaden's program helps businesses use information technology to gain competitive advantage. Some organizations use this technology to great benefit, but rapid technological change makes that difficult especially for smaller enterprises. The Center for Enterprise Systems improves a company's competitiveness by redesigning its business processes and then developing a road map for its information technology.

The center's activities include:

- Helping enterprises to design, implement, and manage their enterprise systems
- Using guided research to advance enterprise systems engineering
- Training others to apply this new knowledge through workshops and seminars

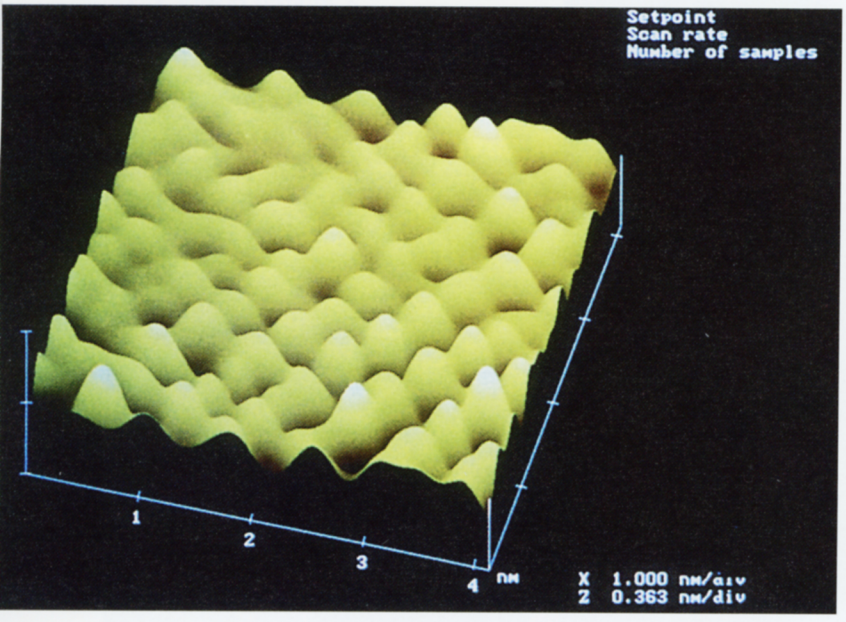
Competitive Information Technologies

Myron L. Cramer, Ph.D.

Dr. Myron Cramer has initiated a new program addressing the competitive perspective of information technologies as they relate to government and business. Within the government, this area is known as "information warfare" (IW), and it includes techniques and technologies used to gain a competitive advantage over adversaries or competitors. The elements of Competitive Information Technologies (CIT) include information collection, denial, protection, transport, and management.

Currently planned research includes:

- Developing and testing a set of metrics to support evaluations and analyses of vulnerabilities and opportunities
- Developing a theory of equities to address the fundamental issue of how to strike a balance among elements of CIT/IW
- Research into related advanced concepts such as in inter-network surveillance, situational recognition and awareness, active discovery, and risk assessment



Images produced by atomic force microscopy show atomic-scale surface details in a fluid-cracking catalyst to help scientists improve process efficiency.

Hybrid Optical/ Digital Image Processing

William T. Rhodes, Ph.D.

Dr. William Rhodes leads an applications-oriented program in image processing, emphasizing research in hybrid optical/digital implementation. Recent accomplishments include:

- Imaging through turbulence and diffusers via enhanced backscatter
- Controlled aliasing for reduced bandwidth high-definition imaging systems
- Intensity-dependent summations for vision simulation systems
- Application of min-max, smart-pixel arrays to vision simulation and target acquisition
- Development of adaptive telescope systems

Undersea Research

Gary Caille, Ph.D.

Dr. Gary Caille studies structural and shallow water acoustics and submarine sonar systems. He is developing sonar applications to take advantage of submarine hull coatings and structural acoustics properties.

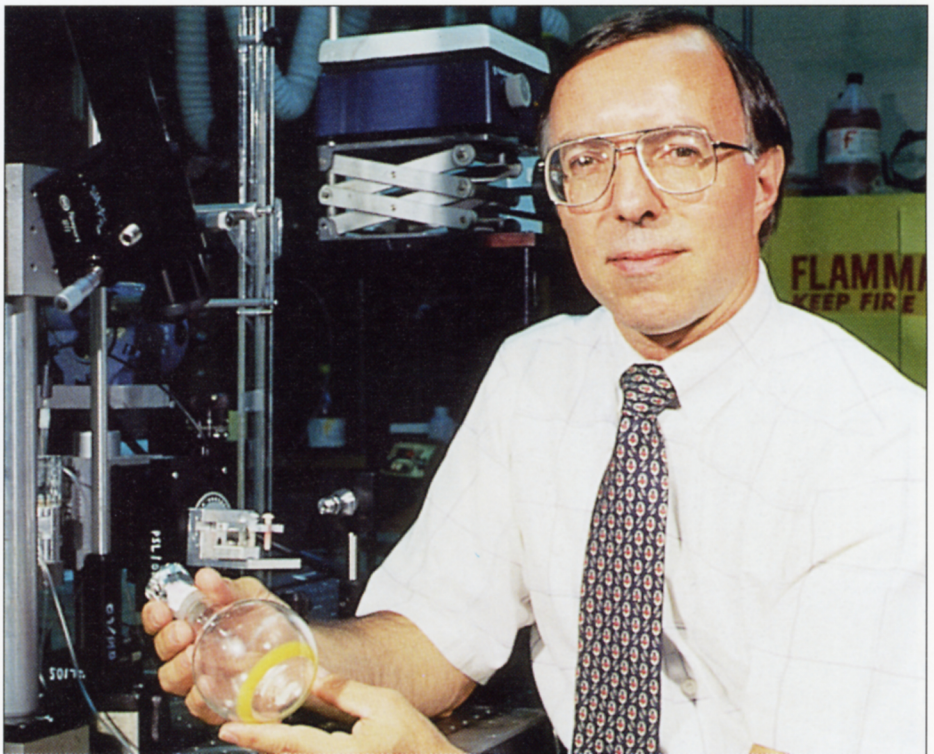
Caille's group is collaborating with the University of Miami and the Naval Surface Warfare Center to develop an underwater natural laboratory in the Florida Straits for research ranging from basic sound propagation studies to system development and testing. The group has also worked with the Navy Submarine Medical Research Laboratory and Emory University Medical School studying the effects of low-frequency sound on swimmers and divers.

Zeolites and Clay Research

Mario L. Occelli, Ph.D.

Dr. Mario Occelli is developing new catalysts for the petroleum and chemical industries. Occelli recently received a three-year, $588,000 contract from Hoechst-Celanese Corporation to synthesize and study solid catalysts and a second $97,000 contract from a European company to continue study of a metal-resistant cracking catalyst.

In a recent program Occelli's group used atomic force microscopy to improve understanding of the role that surface architecture has on the catalytic properties of microporous solids.



Robert Schwerzel leads a research effort to prepare novel colloidal "quantum dot-quantum well" semiconductor nanoparticles for nonlinear optics applications.

Continuing Research Programs

Acoustics

GTRI is contributing to a national effort aimed at quieting jet aircraft. Researchers are locating sources of jet engine noise using elliptical mirror and coherence-based techniques, and developing methods of reducing noise using plume mixing, vibrating splitter plates, and miniature air jets. Similar research efforts are concentrating on reducing internal aircraft noise. In other noise control research, GTRI is developing active noise control by imposing additional noise of equal intensity and opposite phase.

In research critical to NASA's efforts to make the High Speed Civil Transport acceptable for civilian flight, GTRI scientists are using a unique 40,000-watt speaker system to study the impact of sonic booms and other loud noises on human subjects and structures.

Automobile noise provides another focal point for research at GTRI. In a groundbreaking study, researchers used a vehicle equipped with sophisticated instrumentation for road testing that ranked wind noise sources in cars.

GTRI researchers are also studying the acoustic properties of materials. One group is investigating new high-temperature liners, such as an innovative ceramic liner, for acoustic applications. Another team, funded by NASA Langley, is analyzing the effects of unusual ambient conditions on the sound-absorbing properties of materials that may convert aerodynamics wind tunnels into aeroacoustics wind tunnels.

Aerospace Sciences and Technology

GTRI is researching and developing technologies for use in air, ground, and waterborne vehicles and transportation systems. While many of these programs are sponsored by the Air Force, Army, Advanced Research Projects Agency, and NASA, the U.S. and Georgia Departments of Transportation and private industry are also sponsoring projects. In one project, GTRI is working with the FAA and a local heliport to properly integrate helicopter operation into the Southeast region.

GTRI is playing a critical role in improving the airworthiness of the MH-53 and H-60 helicopters for the Air Force Special Operations Forces. This study includes structural integrity, damage tolerance, flight performance, and flight test management. This type of work will become more critical to both the defense and commercial sectors as replacement rates decline and aircraft are expected to remain in service longer.

GTRI's research in experimental and computational aerodynamics provides insight on improving the performance of high-lift wings for advanced subsonic aircraft and understanding the aeroelastic behavior of aircraft surfaces exposed to supersonic and hypersonic flows. In a related project, researchers improved the aerodynamics of racing hydroplanes to significantly increase the speed and safety of these high-speed boats.

Communications

GTRI research has improved communications design and quality in a variety of conditions and settings: network design and application; business support through technology assessment; radio location and direction finding; and privacy and security in wireless communications. Increasingly, researchers are applying telecommunications technology to design products for the vendor community in wireless systems and digital transport systems and networks. They are also resolving key technical issues in development of new services by telecommunications service providers. One GTRI team has developed a cell engineering tool for engineers to optimize personal communications network design in large buildings.

Another program has resulted in new, adaptive techniques that allow high-quality communication in the presence of interference in crowded parts of the radio spectrum.

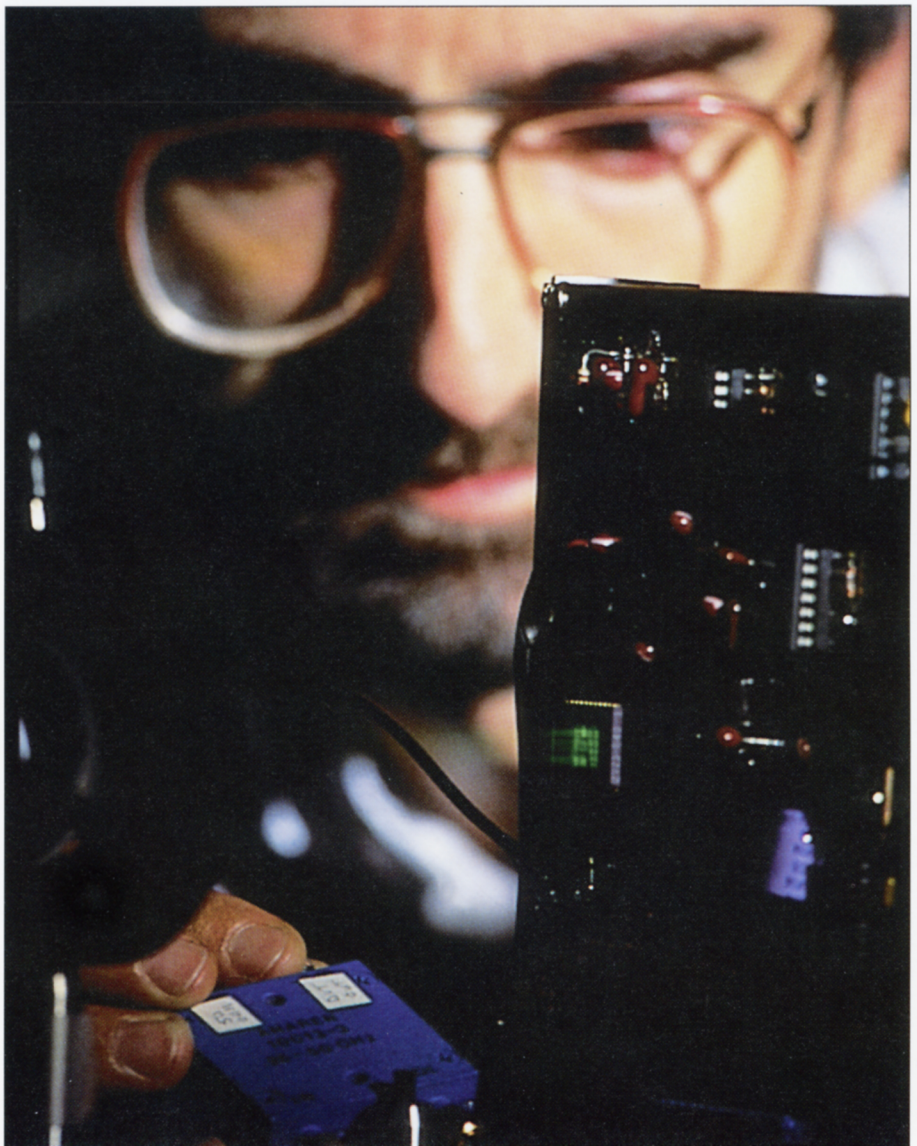
GTRI researchers in advanced digital networks have concentrated on integrating satellite communications with Integrated Services Digital Network (ISDN) technology. They have also established a multimedia network for voice, data, image, and video information.

Electromagnetic Environmental Effects

Command, control, communications, and intelligence systems are used everywhere, from "smart homes" to manufacturing to defense systems. Since these systems are vulnerable to environmental extremes, GTRI's research in understanding, detecting, measuring, and preventing such disturbances plays an important role in keeping these systems working.

GTRI has developed a cell for evaluating shielding effectiveness of planar materials and electromagnetic interference gaskets.

GTRI researchers have also developed manuals, courses, and other means to educate those whose work requires them to understand electromagnetic effects. They have compiled materials to help managers ensure that electromagnetic interactions do not occur, and to explain transient protection technology for traffic control engineers and technicians.



This page: *GTRI engineers evaluated the susceptibility of CCD chips and other photonic devices to electromagnetic interference.*
Opposite page: *Special instrumentation, such as a bicycle wheel and surface-mounted microphones, helped GTRI researchers study sources of automotive wind noise during road tests.*

Continuing Research Programs

Electronic Defense

GTRI is developing ways to put new technology into older electronic defense systems so the Department of Defense can avoid the expense of developing new systems. Researchers have designed and built hardware and software that integrates existing defensive and offensive avionics systems, as well as systems which consolidate electronic warfare controls and displays while coordinating system responses.

GTRI researchers have developed support stations for testing, developing, and maintaining electronic warfare software and hardware. They have worked extensively in the mathematical modeling and analysis of electronic warfare systems, including both coherent radars and countermeasures. They also have developed countermeasures techniques for coherent radars, and have designed and built a radar signal simulator which can mimic radar pulses with almost any intrapulse characteristics.

In other work, GTRI researchers are using neural network technology in a particularly difficult pattern recognition problem, engineering and simulating selected paradigms for comparison with existing algorithms for classical techniques.

Energy Development

Georgia Tech researchers are exploring the development of new energy sources while decreasing the environmental impact of creating energy. One of GTRI's strengths in this area is its ability to link diverse technical skills in research groups. One interdisciplinary team from GTRI and Georgia Tech's Construction Research Center is developing plasma arc technology for energy and environmental uses. Other researchers are developing ways of converting waste materials such as municipal solid waste and paper-recycling sludges into synthetic gas and other byproducts.

GTRI is also developing anaerobic biological waste treatments which eliminate or reduce wastes and produce biogas. Other researchers are working with the American Society for Testing and Materials to develop testing procedures for biomass conversion systems that generate energy from raw material feedstock and wastes.

GTRI engineers also work with organizations to reduce energy use. One such program, the Energy Management Assistance Program (EMAP), assists public school systems in making optimal use of their energy efficiency budgets. Companies can turn to the Industrial Energy Extension Service or the Energy Analysis and Diagnostic Center for GTRI's assistance in using energy more efficiently.

Environmental Science and Technology

Environmental engineering research emphasizes treatment and use of technologies for pollution prevention and waste reduction. Areas of focus include industrial wastewater treatment, municipal solid waste treatment, industrial pollution prevention, plasma-arc technology, and energy-reduction technologies. Researchers are also developing databases and models of nearly all aspects of the environment, and engineers are helping industries comply with environmental regulations and reduce waste through the Tech Waste Reduction and Environmental Compliance (WREC) program.

Environmental policy researchers are studying the management and organizational aspects of pollution prevention, environmentally conscious manufacturing, and innovation.

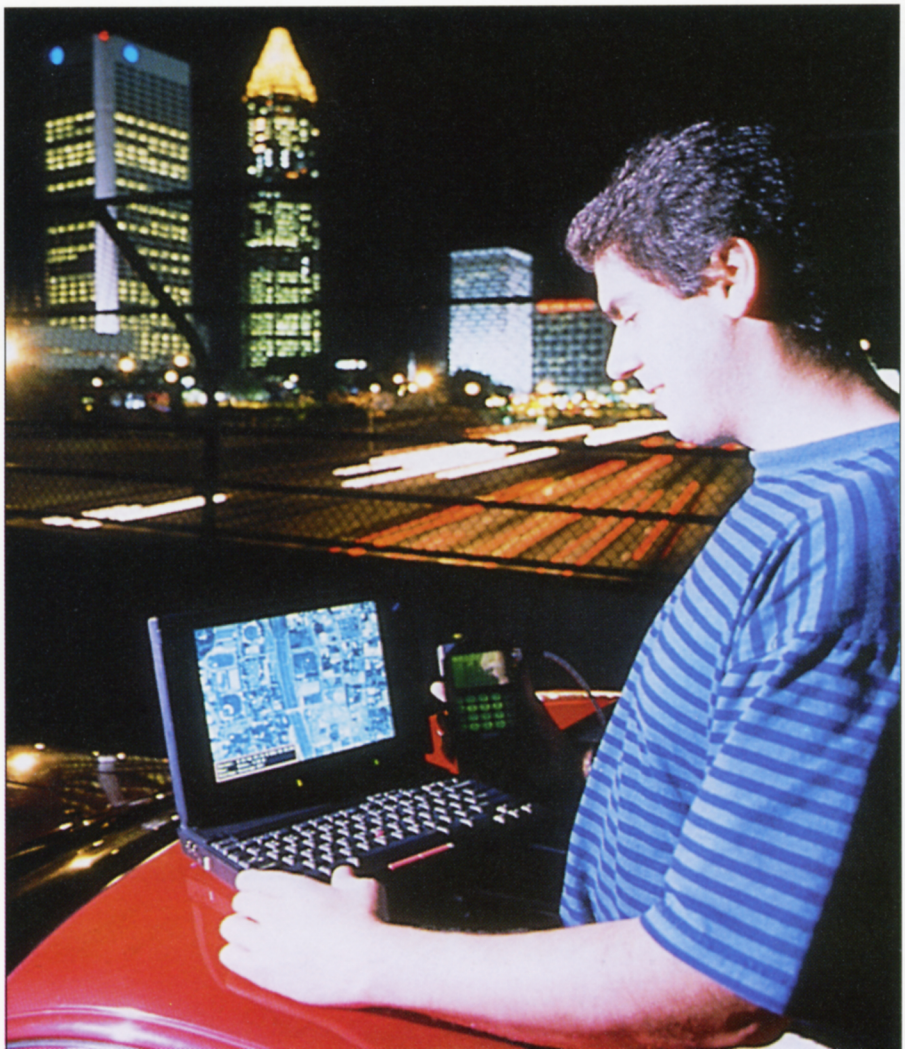
GTRI researchers are also studying indoor environments. One project is developing new methods to detect contaminants in ambient air, building products, and furnishings. Another project is adapting integrated optics sensor technology for direct detection of a variety of low-level pollutants.

Information Technology

GTRI researchers are involved in a variety of software engineering projects emphasizing methodologies, languages, and management. Through these studies, GTRI is establishing methods for application and standardization in government and industry.

More than 400 TEMPEST-certified workstations based on a GTRI design have been installed throughout the world to support intelligence analysis. GTRI researchers also developed the primary software for the Tactical Air Forces Mission Support Systems. In addition, they helped develop the Heuristic Route Optimization (HERO) program for threat/penetration interaction and route analysis. Other tools originally developed for the military were incorporated into systems to solve traffic routing problems.

Researchers working in communications and systems engineering are developing an automated intelligence processing local area network, incorporating imagery, automated cartography, database distribution, and electronic mail. Specialists in artificial intelligence and neural networks built systems for a variety of applications, including autonomous vehicle systems, knowledge-based route planning, image understanding systems, intelligent data fusion, and heuristic planning and scheduling.



This page: *A mapping system originally developed to help pilots plan routes could also be used by police, fire, and other emergency services to track ground vehicles.*
Opposite page: *Electronic countermeasures hardware and techniques are evaluated in the Digital RF Memory (DRFM) Laboratory, using GTRI's Generic Doppler Processor.*

Continuing Research Programs

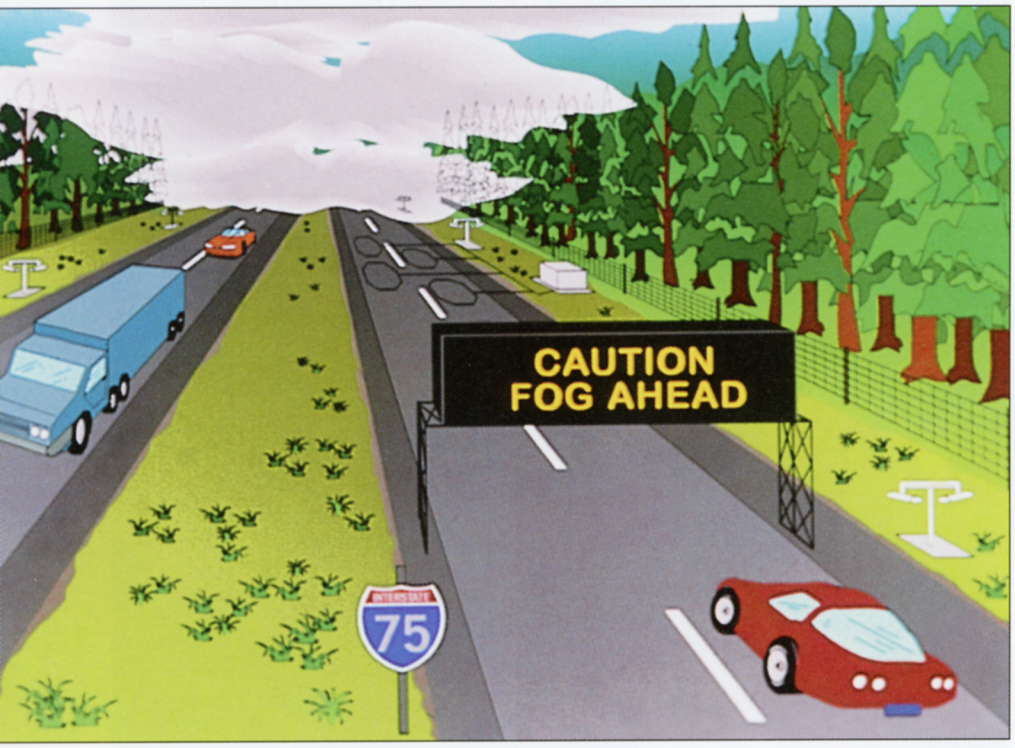
Infrared/Electro-Optics

GTRI's research in infrared and electro-optics has produced models and technologies which have been used in both military and industrial applications. Field measurement projects collect data to generate or validate signature models, record radiometric imagery of test scenes for use in interpretation of test results, and generate digital imagery of real-world scenes for use in computer simulations. Other signature analysis work has concentrated on nonconventional airborne engagement scenarios.

To assist industry in enhancing productivity, GTRI is adapting modern optics to industrial processes. Integrated optics technology offers innovative sensing approaches, along with great reductions in sensor size and cost.

GTRI researchers have developed a computer vision model that mimics how a weapon systems operator picks out targets on a busy landscape; this will provide information for making military vehicles less visible to enemies. Another group of simulations, the Georgia Tech Synthetic Imaging Missile Simulation (GTSIMS) has been widely used to evaluate aircraft self-protection concepts.

One group of GTRI researchers is cooperating with the Georgia Department of Transportation to design and build an automated adverse visibility warning system which will improve highway safety by monitoring visibility and warning drivers of poor visibility.



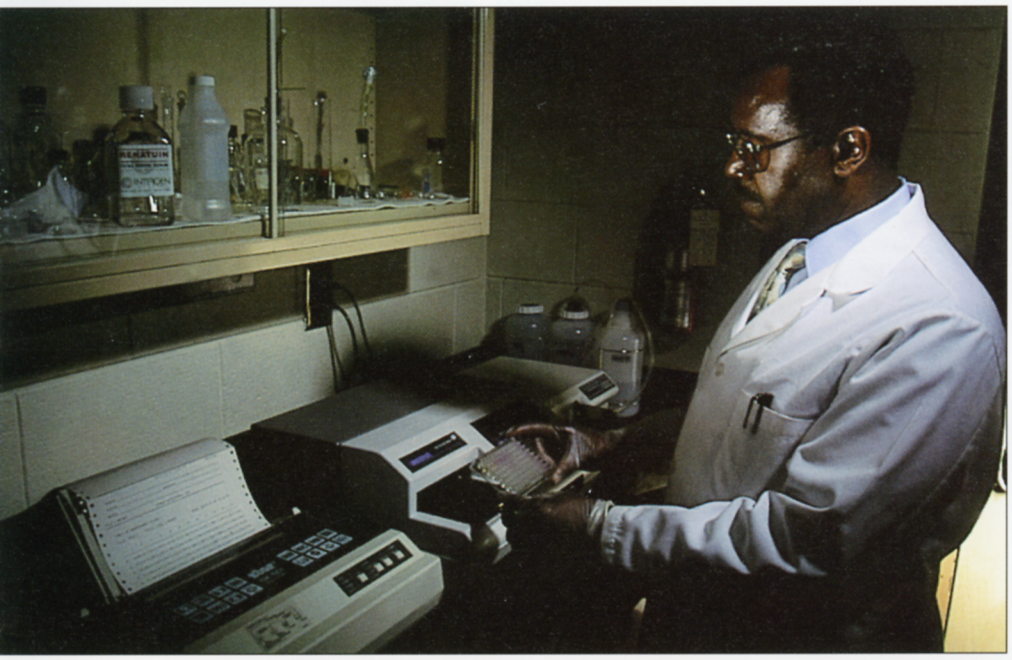
Manufacturing Technology

GTRI's comprehensive program in manufacturing research and development includes basic materials and process investigations, controls research, systems planning, and pilot production. These programs benefit from major facilities in Georgia Tech's Manufacturing and Microelectronics Research Centers. GTRI's strong capabilities in optoelectronics have led to research on manufacturing integrated optoelectronic devices for sensing, signal processing, and photonic interconnects.

Research in life-cycle engineering has led to tools for diagnostics and plant design, as well as development of computer-aided engineering systems for designing electronic systems and automated test plans.

GTRI's robotics research addresses important challenges in industries intent on lowering costs and improving quality. Researchers are developing new end-effectors to manipulate non-rigid objects in food processing, apparel, and composites manufacturing. Other research has developed new guidance and control systems for advanced material handling systems, such as automated guided vehicles.

Microfactories are a research interest of growing importance. GTRI has helped develop the Apparel Manufacturing Technology Center that includes a microfactory for experimental production of military uniforms. Similar facilities for food processing exist, and facilities for electronics manufacturing are being developed.



This page top: *A researcher from Georgia Tech's School of Biology records the results of a test that detects salmonella bacteria as part of a collaborative research effort to develop an optical biosensor.*
This page below: *Researchers from Georgia Tech's School of Electrical and Computer Engineering are collaborating with GTRI optoelectronics engineers.*
Opposite page: *GTRI researchers are working with researchers from the Georgia Department of Transportation to design and build a fully automated adverse visibility warning system to tell motorists about fog hazards on a section of Interstate 75 in south Georgia.*

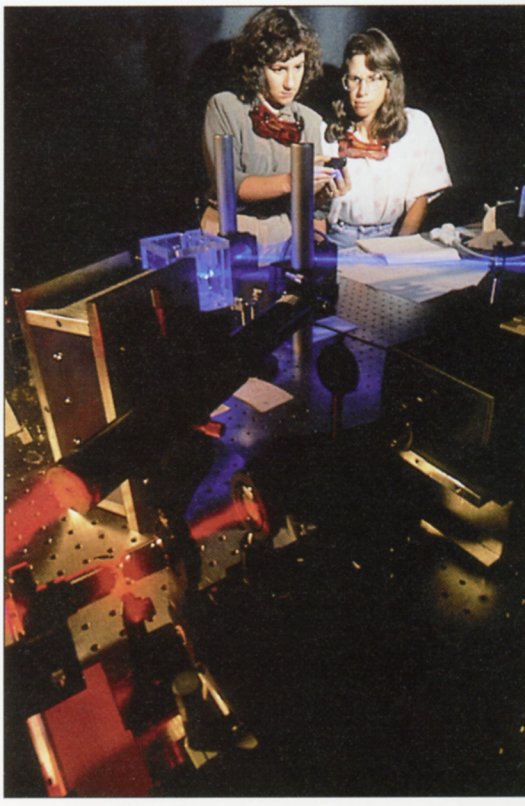
Materials Science

Materials science researchers at GTRI have been conducting research and development projects which have led to the development of new materials and the improvement of existing materials. GTRI scientists also operate the Materials Characterization Center that conducted more than 50 projects for Georgia businesses in 1994.

A primarily industrially supported research program in zeolites and clay catalysts focuses on production of catalysts for the petrochemical industry, particularly production of catalysts that produce environmentally benign fuels for transportation. In addition, researchers are working to understand the nature and identity of dopants and impurities in polymer containers.

A major collaborative program is developing and implementing environmentally benign solvents for cleaning electronic circuit boards. Other significant studies emphasize environmentally benign methodologies for catalyst preparation.

High-temperature materials research in materials science produced a fiber-coating process suitable for production of low-cost ceramic fibers and coatings. GTRI research also addresses a variety of metal processing concerns, including reliability of copper wire for microelectronic connections; thermo-mechanical treatment and structural and property relationships of aluminum alloys; improving the anticorrosion properties of ferrous metals; and improving the surface quality of bare steel wire.



Continuing Research Programs

Microelectronics and Applications

GTRI has a broad range of capabilities for the design, fabrication, and characterization of advanced semiconductor device structures. Researchers have established expertise in the development of infrared detector materials, advanced structures for high-definition television (HDTV) cameras, and millimeter wave devices.

GTRI is extending its research in a number of critical areas including the phosphor technologies essential to creating high-definition displays. The headquarters for the ARPA-supported Phosphor Technology Center of Excellence, a collaboration among six universities and research organizations, is at Tech's Manufacturing Research Center.

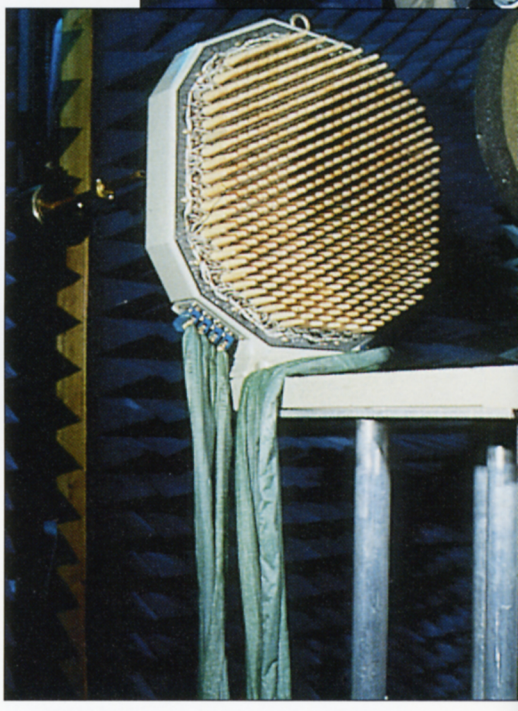
In the area of millimeter wave devices, GTRI activities have focused on refinement of a quasi-optical device combining output power from an array of solid-state microwave and millimeter-wave devices. This research will lead to lightweight, low-power millimeter wave power sources, which can be used for target tracking and commercial activities such as avoiding air and highway collisions.

Radar

GTRI researchers develop and enhance radar systems including large phased array, surface-based surveillance radars, air traffic control radars, and millimeter wave sensors and seekers for government and industry. Programs study and predict radar performance under wide-ranging weather and jamming conditions. They also design, develop, and test radars and radar simulations for electronic counter-countermeasure evaluation and missile threats.

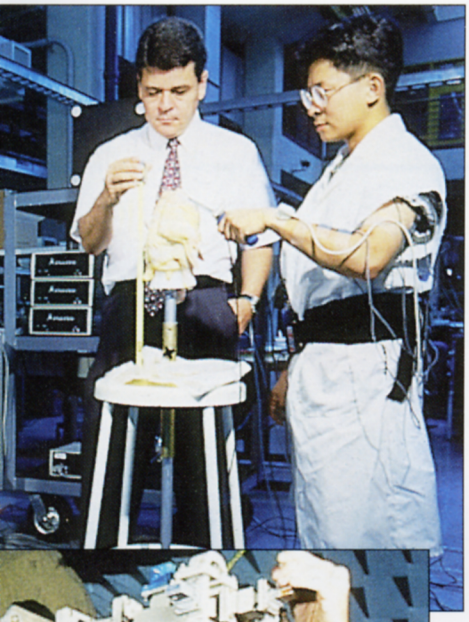
Researchers have investigated single-and dual-mode seeker performance, developed sensor-fusion techniques, and worked with smart-weapons development programs. One project has developed an aid for aircraft landing in poor visibility conditions using a real-aperture millimeter wave radar to map and display the scene on a pilot's head-up display.

In other research, GTRI has developed and demonstrated a new algorithm for target detection and discrimination. Researchers are also studying radar detection and tracking performance constraints, and the use of radar-like signals to characterize electromagnetic scattering by complex objects.



***Opposite far right**: Plasma arc torch technology is being studied for possible new applications in waste disposal and energy production.*
***Bottom:** A policy researcher at GTRI is studying the evolution from a state-controlled economy to a market economy in Bulgaria.*

***Middle:** Researcher adjusts a Russian-built demonstration phased array antenna. GTRI engineers are evaluating the technology used in the SA-12 surface-to-air missile for potential commercial application.*
***Top:** GTRI's Ergonomic Work Assessment System evaluates workers' exposure to risk factors associated with cumulative trauma disorders.*



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Georgia Tech
RESEARCH INSTITUTE

"..whatever you do or dream you can, begin it. Boldness has genius, power and magic in it."

—Goethe

Strategic Plan

The research conducted by the Georgia Tech Research Institute (GTRI) reaches back to the first half of the twentieth century, and the discoveries and practical applications of GTRI technologies have helped to define today's world and have played an important role in bringing the Cold War to a close.

Early in 1994, the leadership of GTRI came together to review the organization's strategic plan, particularly as it applies to the directions of research that are evolving as the twenty-first century becomes a reality. A series of meetings resulted that addressed issues as diverse as worldwide pressures resulting from rapidly changing defense needs, tightening global economic conditions, societal crises, and new directions of emerging technologies.

The result is this updated strategic plan—a roadmap to guide GTRI into the new century.

Our Vision

Working closely with the academic colleges and interdisciplinary centers in areas of research, education, and service, GTRI will be a vital force in establishing Georgia Tech as the premier technological university of the twenty-first century. GTRI will be the most respected university-based applied research institute in the nation.

GTRI indoor air quality research is uncovering the causes and cures for "sick building syndrome."

1994 GTRI Annual Report